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WO-23



Forests for Our Needs

1979 Research Accomplishments

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1979 Research Accomplishments Forests for Our Needs

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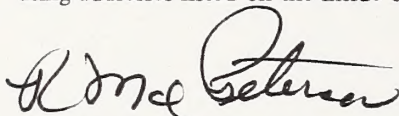
Foreword

The Forest Service, through basic and applied studies, has been working to develop new technology needed for public land management, State and other agencies, various private organizations, the small woodland owner, and individual private citizens including the urban dweller—all forest users.

We conduct research at eight regional forest experiment stations located around the country and at the Forest Products Laboratory at Madison, Wisconsin. We also conduct international studies in forestry, as well as cooperative research with universities and other organizations.







This report contains over 40 short research highlights that provide scientific and technical knowledge needed to protect our Nation's natural resources, help us gain maximum benefit from their use, and leave the environment unspoiled.

Starting on page 44 is a list of publications issued during fiscal year 1979 by our Forest Service research staff. For additional information, please contact the appropriate research headquarters directly, using addresses listed on the inside back cover.

A handwritten signature in black ink, appearing to read "R. Max Peterson". The signature is fluid and cursive, with the first name "R. Max" and last name "Peterson" clearly distinguishable.

R. MAX PETERSON
Chief

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Environment

Surface Mine Spoils in the East

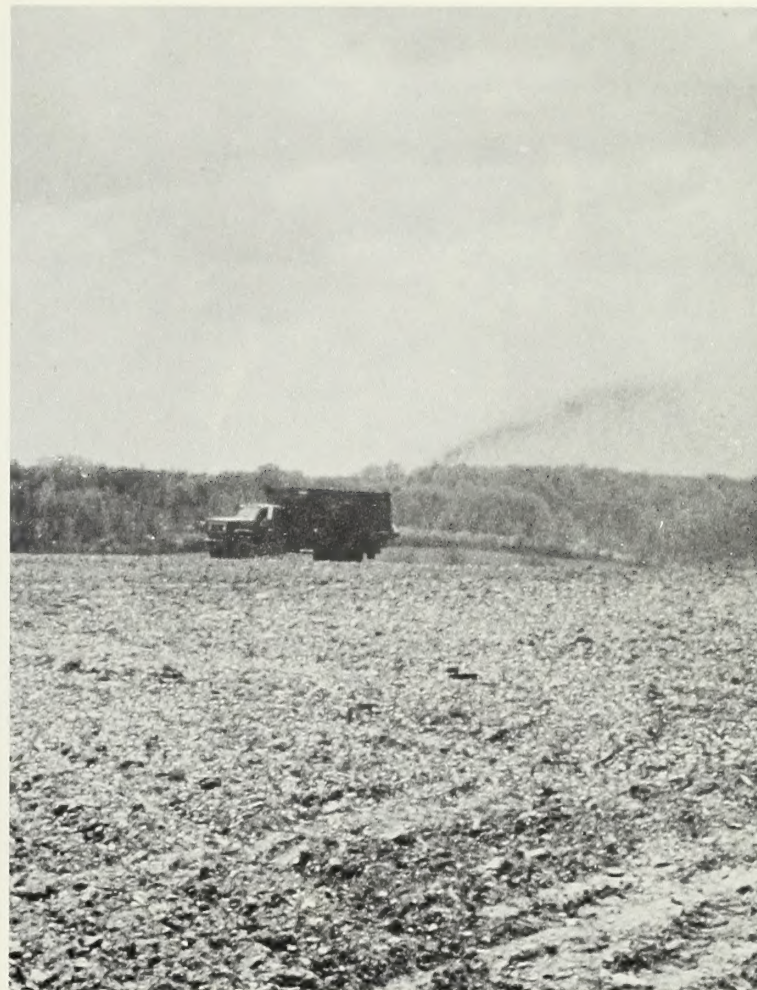
Revegetation of surface mine spoils is important for controlling erosion, enhancing aesthetics, and restoring the land to a productive use. Studies show that planting of compatible combinations of species will produce a quickly established ground cover and a permanent or long-lived cover and product. Vegetation of steep slopes and toxic spoils often requires the application of soil amendments, planting of acid-tolerant species, and introduction of beneficial microorganisms.

Research on various species of microorganisms that are known to form mutually beneficial associations with plant roots is showing the importance of these organisms in establishing good vegetation on mine spoils. Studies indicate that hardwood bark and woodchips also have promise as mulch materials used in establishing vegetation on surface-mine lands.

A manual to aid land managers, landowners, and mine operators in revegetating surface mined areas for wildlife in eastern Kentucky and West Virginia has been published.

A second manual concerning revegetation of mined lands in the Eastern United States is nearing completion. This publication will cover selection of species for quick cover, for erosion control, selection of permanent species for long-term cover, and techniques for sampling and evaluating mine soils to guide selection of appropriate plant species and needed amendments.

Serious adverse effects on the environment both on and off the mining site result when sediment and chemical pollutants enter streams. Research is underway to determine the quantities and to characterize sources of sediment and chemicals reaching streams from mined areas.



Tree chip mulch application to help establish vegetation on strip mined lands in the East. NE



A bright green parrot, one of the rarest of endangered species, confined to the Luquillo Forest. SO

More Parrots of Luquillo

Human intrusion into the tropical forests is jeopardizing the habitat of thousands of animal species. In the Luquillo Experimental Forest, only 13 Puerto Rican parrots were living in 1974. Research on this endangered tropical bird has increased their number to over 30 in the wild in 1979.

Cooperative research between the Southern Forest Experiment Station and the Fish and Wildlife Service led to development of nesting structures that frustrate predators such as the pearly-eyed thrasher and rats. Nests remain dry even in the wet tropical mountain habitat.

Scientists can now tell the sex of parrots by analyzing stool samples, and can select compatible mates for captive breeding by watching the habits of individual caged birds. Hispaniolan parrots from the Dominican Republic make excellent foster parents and have been successful in hatching Puerto Rican parrot eggs and raising nestlings. Then, before fledging, these fostered birds can be transferred to active Puerto Rican parrot nests. This technique can insure that each active wild nest fledges a maximum brood of three to four birds.

Research will continue until the population has been built to 200 nesting pairs and nesting sites are established in two or more different locations in Puerto Rico. Management of the species will then be turned over to action agencies on the island.

Wildlife Habitats in Managed Forests

Forest managers throughout the country are beginning to use a new system to improve habitat for wildlife in managed forests in response to recent legislation concerning wildlife needs.

This system was developed by researchers at the Pacific Northwest Forest Experiment Station in cooperation with The Wildlife Management Institute, the USDI Bureau of Land Management, the National Forest System of the USDA Forest Service, and State fish and game departments. This new method grew from the need to protect wildlife habitat in eastern Oregon and Washington when salvaging large amounts of timber damaged by a major outbreak of the Douglas-fir tussock moth in 1972-74.

The new system is now being used to improve wildlife habitat management in National Forests in the Pacific Northwest, California, and the Intermountain West, but is generally applicable to managed forests throughout the United States. The publication *Wildlife Habitats in Managed Forests—the Blue Mountains of Oregon and Washington*, USDA Agriculture Handbook No. 553, is available for sale only from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Wildlife Habitats in Managed Forests the Blue Mountains of Oregon and Washington



U.S. Department of Agriculture • Forest Service
September 1979 • Agriculture Handbook No. 553

Wildlife habitat management will be aided by the new publication just off the press. PNW



More people are making use of our rivers for recreation. NC

How and Why Rivers are Used

Recreational use of our Nation's waterways has grown tremendously during the past decade. Managers of Federal, State, and local rivers are increasingly forced to deal with problems such as conflicts among user groups, depreciative behavior, crowding, and environmental impacts. To deal with these problems, and also to be adequately prepared for developing sound management plans, managers need a cost efficient mechanism to find out how river recreationists view management problems and their solutions.

North Central Forest Experiment Station's research, through input and cooperation of Federal and State land management agencies, has developed a standardized mail questionnaire capable of yielding information on river use and nationwide user preferences. Issues covered by the questionnaire include reasons for visiting the river; number, severity, and kinds of problems encountered; level of trip satisfaction; perception of crowding and conflict; level of support for a variety of management practices; and descriptive characteristics of the user and of the trip.

Over 30 rivers have been studied. Study results will provide the basis for developing trends through followup investigations.

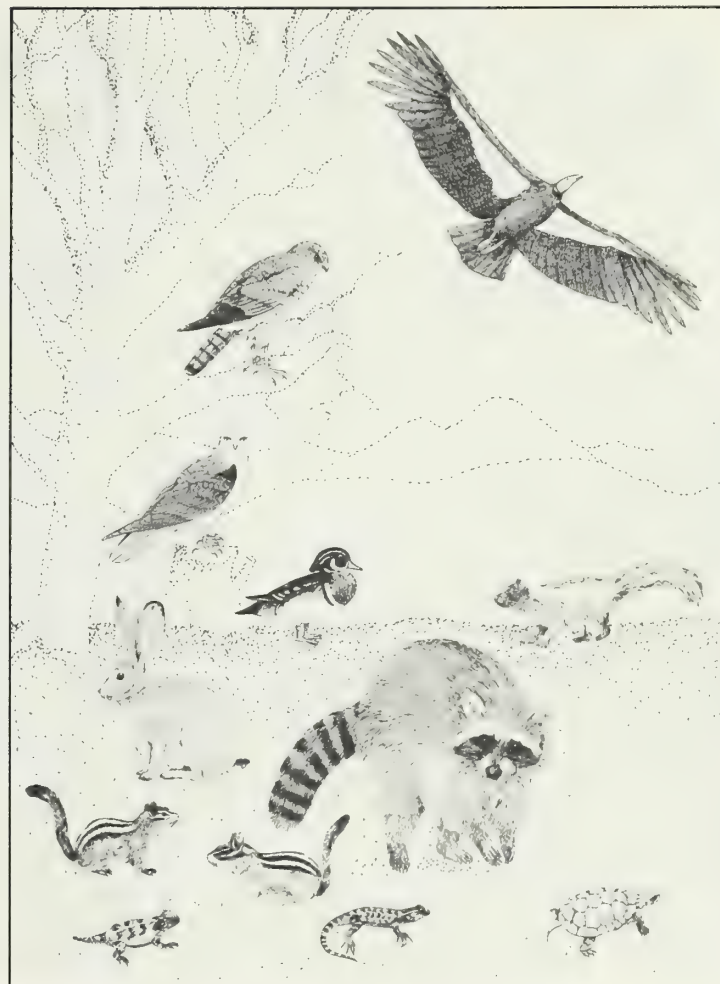
New Guide for Wildlife Needs

Managers of National Forests and land managers have a responsibility to consider the different needs of all forest wildlife when developing forest management plans.

The Pacific Southwest Experiment Station and Pacific Southwest Region (Region 5) have produced a data base of 355 species of wildlife in the Western Sierra Nevada. This new data base is available both as written report GTR-PSW-37 and in a format suitable for computer access and analysis from the Pacific Southwest Region's Wildlife Management Staff in San Francisco.

For each of the birds, mammals, reptiles, and amphibians described in the report, information about the life history, distribution, and habitat needs is presented, along with a sketch of the species and a map of its distribution. The most important feature of the data base is the species-habitat matrix, which depicts the plant communities each wildlife species needs at different times of the year.

The report is the only one of its kind on California wildlife and was carefully designed to be a convenient, easy-to-use field reference. Both the publication and the computerized data base offer California wildlife biologists, silviculturists, and others an invaluable aid for determining possible impacts that timber harvesting, prescribed burning, roadbuilding, and similar forest management activities might have on their forest's wildlife.



Management plans requirements to help all forest wildlife. PSW



Canoeists and fishermen have conflicting interests. RM

Identifying Outdoor Recreation Benefits

Because most publicly provided outdoor recreation opportunities are not allocated by competitive market prices, too little is known about the benefits these outdoor recreationists receive.

Researchers at the Rocky Mountain Experiment Station have been looking for a way to get better measures of both economic and noneconomic outdoor recreation benefits.

Survey research techniques have been developed to identify the reasons why different types of people interested in outdoor recreation decide to participate in particular activities, and to quantify the benefits these same people feel they receive.

Research has led to the development of an outdoor recreation resource inventory and management system. The system can be used to map public lands to show which areas can best be managed to provide specific types of recreation opportunities. This system has been adopted nationwide by the Forest Service and the Bureau of Land Management.

Sewage Waste Put to Use

American cities are producing huge volumes of sewage sludge, and many cities are running out of places to put it. Scientists at the Southeastern Forest Experiment Station find sludge can do much to restore the productivity of the soil of millions of acres of land disturbed by strip mining, severe erosion, and borrow pits.

Severely disturbed and eroded sites in eastern Tennessee have defied reclamation for many years. Application of sewage sludge prior to planting of pines there has greatly increased seedling growth. On a borrow pit in South Carolina, loblolly pine growth during the critical first 3 years after planting was increased 20-fold by applying 1/2 inch of sewage sludge prior to planting. On plots where sludge was not applied, 500 pounds per acre of 10-10-10 fertilizer and 2,000 pounds per acre of lime were applied. Researchers found the sewage sludge far more effective than commercial fertilizer and lime for this kind of reclamation.

Scientists at the North Central Forest Experiment Station have been concerned with the land management of 160 sewage lagoon systems in Michigan and neighboring States.

Hybrid *Populus* plantations have been established and studied. Scientists found that forest vegetation can be used to remove large amounts of nitrogen contained in wastewater from sewage oxidation ponds. Short rotation culture appears to have a promising role in the design and operation of land treatment systems.



Two-year-old hybrid cottonwoods were irrigated with 2 inches wastewater per week during growing season. NC-SE

More Water Means More Antelope!

We could have more antelope on Great Basin desert lands.

Researchers of the Intermountain Forest and Range Experiment Station and the Utah Division of Wildlife Resources have completed a series of studies showing the major reason why antelope do not occupy much of the potential range—poor distribution of a few existing watering places. The topography and the forage are there but, unfortunately, the water is not. The development of additional watering places is the key to expanding the antelope range.

Researchers have found that making more water sites available during fawning season helps distribute the antelope population and may lessen the number of fawns killed by predators. And predation is one of the major contributors to the slow growth rate of antelope population.

Research results are being applied by the State of Utah through construction of rainwater catchments and other water developments on potential antelope range. Similar water developments on cold-desert areas of Nevada, eastern Oregon, and southern Idaho could greatly increase antelope populations throughout the Intermountain West.



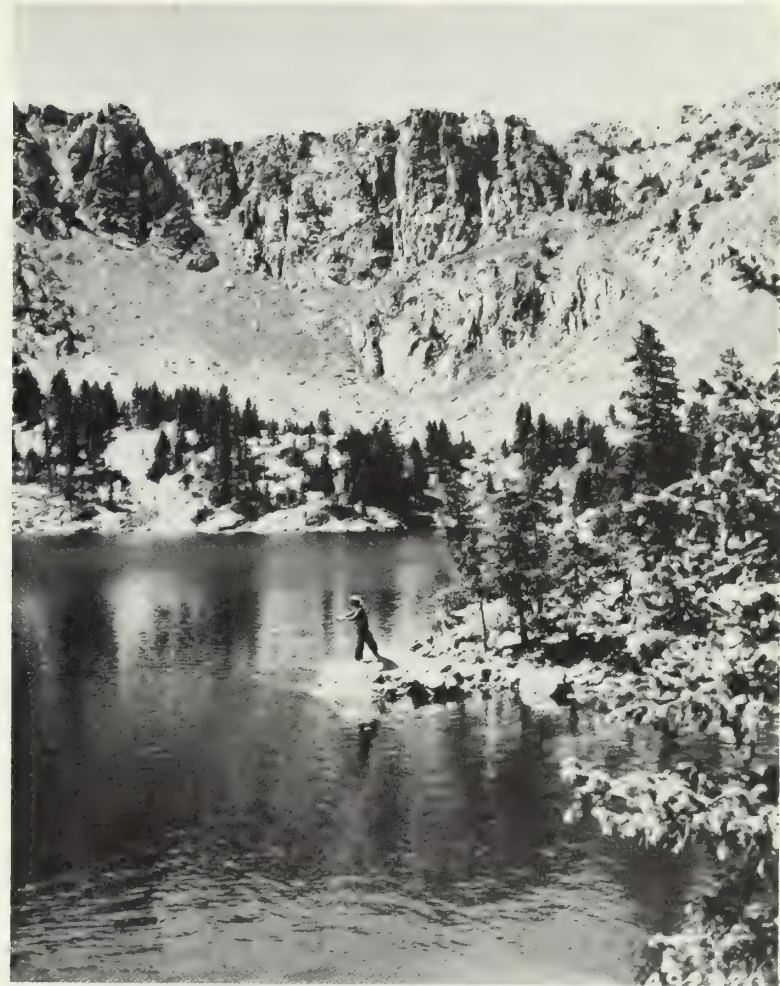
More water sites will help increase antelope population in the West. INT

Managing Our Wilderness

Wilderness must be managed is the premise of a recently published book, *Wilderness Management*, Miscellaneous Publication No. 1365. Although wilderness is intended to be natural and unmodified, increasing recreational use and other influences make it necessary to manage these areas in order to protect the natural values for which they were established.

This publication summarizes the history of wilderness as a land use, discusses legislation protecting wilderness, describes current use patterns and pressures, and shows how research knowledge can be utilized in wilderness management planning. Intermountain Forest and Range Experiment Station and Southeastern Forest Experiment Station scientists cover both management of visitor use and resource protection and describe the relations between the two. This provides a basis for managing visitors with as little regulation and restriction as possible while safeguarding wilderness quality.

The book has already been adopted in many university classrooms and is used as a standard reference by wilderness managers in all Federal land management agencies.



Management of our Nation's wilderness will be helped by this new publication.
INT



Collecting soil-solution samples in an unthinned control plot on the Challenge Experimental Forest, PSW

Forest Fertilization and Water Quality

Research has demonstrated that timber growth can be doubled on certain sites through proper application of nitrogen fertilizers without the risk of contaminating groundwater with nitrate. Nitrates are normally present in low amounts in undisturbed forest soils, regardless of depth.

The Pacific Southwest Station has established a battery of studies in four geomorphic provinces in California to determine not only the benefits of fertilization on timber growth, but also the effect on water quality. The results of the studies have shown that when nitrogen was applied at rates as high as 400 pounds per acre, the nitrate concentrations were comparable to the natural concentrations at a depth of 1 meter below the soil surface. This depth is well above the surface of the permanent water table in the four test areas.

The fertilizers were applied in the fall. When the soil warmed in the spring, the nitrate concentrations tended to intensify in the upper layers of the soil profile. But the tree roots also became more active and effectively absorbed much of the nitrate before it filtered to more critical depths.

Scientists are working on techniques to determine what biological, ecological, and economic returns can be expected from treating forest soils with fertilizer.

These techniques and analyses will be used to produce guidelines or prescriptions for fertilization programs that will increase timber productivity without jeopardizing water quality.

Weather Modification in the Sierra Nevada

In cooperation with the Water and Power Resources Services, U.S. Department of the Interior, hydrologists at the Pacific Southwest Station have produced a set of nine reports that can be used to evaluate the effect of wintertime weather modification on the ecology and snowpack hydrology of the Sierra Nevada mountain range.

The impacts of increased precipitation upon five major ecological areas were estimated from historic snowpack and precipitation data acquired from 1899 through 1974. The estimates covered potential impact on (1) vegetation, including rare and endangered plants; (2) forest insects and diseases; (3) deer and their habitat; (4) nonpoint source pollution; and (5) lake and stream arrival and plant life.

The reports include a bibliography of more than 1,300 citations relating to the impact of weather modifications, and an overview in which responses to public concerns are evaluated.

These reports can be used to evaluate environmental impact statements, to implement such statements, or to assess the utility of weather modification on flood potential, nonpoint source pollution, and reduction of drought stress on plants and animals.



The intertwining network of tree roots provides strength to forest soils. PSW

Strong Roots Hold Soil

Hydrologists and soil scientists at the Pacific Southwest Experiment Station are learning how logging affects the role that roots play in maintaining slope stability in the unstable landscape of northwestern California.

Scientists have found that both tree and brush roots reinforce unstable slopes by tying the soil mantle to parent material and by providing lateral support to the soil mass.

Thousands of roots excavated from unstable sites in northwestern California, Oregon, and Alaska were weighed, measured, and grouped into size classes. Then the roots were tested for shear strength to determine their ability to resist the stresses continually acting on unstable slopes.

The data obtained in these studies helped interpret the interaction of timber harvesting activities and mass erosion process, such as landslides, soil creep, and debris avalanches.

The studies indicated that invasion by brush may not be undesirable from the standpoint of soil and slope stability. Within 12 years after logging, the clearcut blocks were completely revegetated with snowbrush (*Ceanothus velutinus*) rather than conifers. The rootmass of brush is only half that of conifers, but the individual brush roots are twice as strong. The brushfields will add reinforcement to the slopes equal to that provided by the conifer roots.

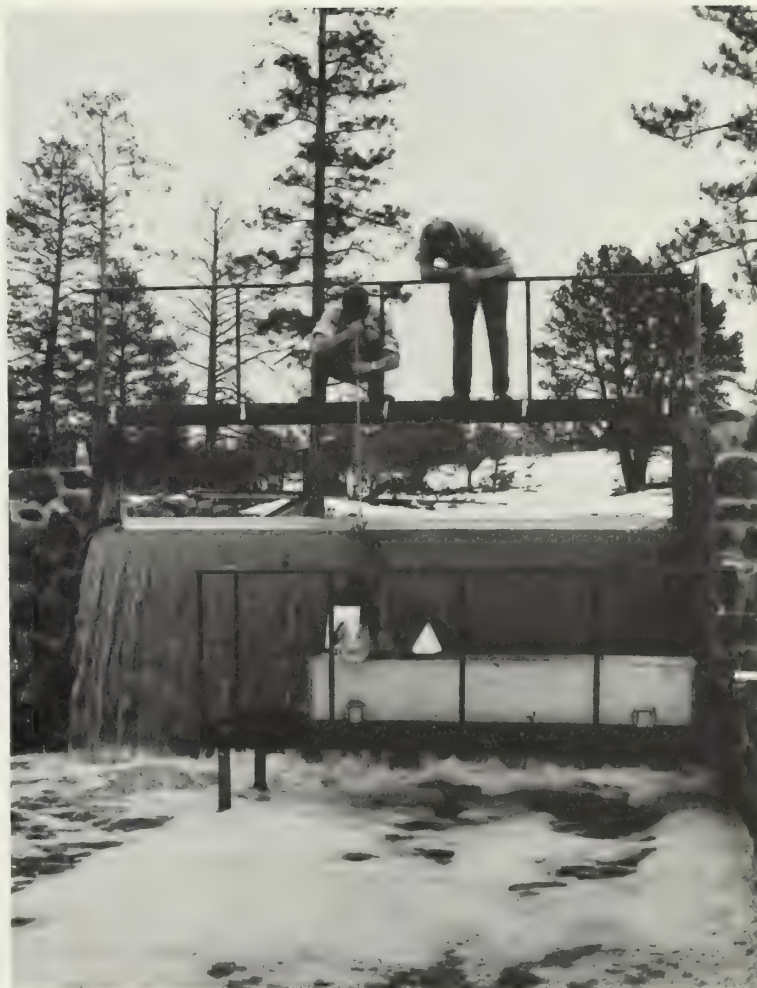
The root-strength studies point up the importance of establishing some type of vegetation as soon as possible after harvesting conifers on stable, but difficult to reforest, landscapes.

For More Colorado River Basin Water

According to scientists at the Rocky Mountain Experiment Station, the annual flow of the Colorado River could be increased up to 6 million acre-feet if all contributing forest and brush lands were managed solely to increase water yields. Such dramatic increases could not be achieved without serious impact to other forest resources including economic, social, and environmental values. Such resources need to be considered.

Water yields in the upper Colorado River Basin could be increased an estimated 500,000 acre-feet by appropriate management of one-fifth of each major vegetation type. Half that increase would come from subalpine forests, where well-designed timber harvests would create small forest openings to trap blowing snow. More extensive treatments would be necessary to get an additional 250,000 acre-feet in the lower Basin. Ninety percent of the increase would be generated by creating a mosaic of grassy openings in one-fifth of the chaparral and by intensive management of a third of the ponderosa pine.

This type of management could also substantially increase yields of timber and forage for livestock, as well as improve landscape aesthetics, recreation opportunities, and habitat for many species of game and nongame wildlife.



Measuring water yield from an intensively managed pine watershed in Colorado River Basin. RM



The rotting timber is residue that should be left to provide needed moisture and nutrients. FPL

Moisture and Nutrients from Residues

Lack of suitable moisture is a deterrent to reforestation in the dry land mass of the Rocky Mountains and westward to the crest of the Sierras and Cascades. Most moisture in this area occurs as winter snowfall and snowmelt in the spring.

Forest Products Laboratory scientists working with scientists from the Intermountain Forest Experiment Station and Michigan Technological University have determined that decayed wood residues and charcoal from fires are very important to forest reproduction in this area and contribute to survival and growth of seedlings and transplants.

Biomass is needed for accumulation and retention of water and minerals. Decaying wood acts as a sponge and enables circulation and change of air in its cavities as well as providing a favorable acidity for conifer growth. Nitrogen, phosphorous, or both, in usable form, are determining factors in plant growth in both decayed wood and moist forest soils.

Decayed wood and charcoal provide a favorable habitat for many kinds of living soil organisms such as mycorrhizal fungi that must be present to associate with roots. These fungi enable plants to accumulate phosphorous from insoluble minerals such as rock and nitrogen and their action is like that of bacteria in the intestinal tracts of animals. Mycorrhizae require constant moisture, correct acidity, and adequate aeration provided by charcoal or wood in advanced decay. Studies have shown that in drier areas of the West, forest managers must leave some residues to provide moisture and nutrients for reforestation.

Research Helps Western Reclamation

Seventy-two percent of our Nation's coal reserves are located on federally administered lands in the West. As development of these resources progresses, a key problem has been how to revegetate surface mine spoils with the objectives of controlling erosion, enhancing aesthetics, and restoring the land to productive use.

When strip mining of coal accelerated in the early 1970's in the Four Corners region of the Southwest, the biggest reclamation concern was whether vegetation could be reestablished on these low rainfall sites. Research by the Rocky Mountain Forest and Range Experiment Station and mining company reclamation specialists has shown that plant establishment is practical and feasible.

Four native species have been established and maintained on mined lands in New Mexico's San Juan coal province. Research is concerned with the management of these and additional plants so the lands can be returned to their historic grazing use.

Researchers at the Intermountain Forest and Range Experiment Station and Montana State University, Bozeman, have developed a prototype minicomputer-based planning system to develop mine plans and reclamation strategies, and to estimate environmental impacts. This system is a powerful planning tool, combining the speed and accuracy of the computer with the professional judgment of the specialist-operator.

Efficient data management features allow the operator to use information on coal, overburden, climate, hydrology, vegetation, and wildlife. Maps, cross-sections, isometric drawings, and other data displays can be created in minutes.

This prototype planning system is located on the Montana State University campus and is available for demonstrations and expanded research.



*Researchers study results of revegetation efforts on mined lands in the West.
INT-RM*



Fire and Atmospheric Sciences

Weather Information for Foresters

Prescribed burning, fire control, tree planting, use of heavy equipment, and nursery spraying are strongly influenced by weather conditions. Forest managers faced with these conditions have needed more information about the weather than they could get directly from the National Weather Service.

The need for weather information is especially acute for someone trying to estimate the rate and pattern of smoke dispersion from a prescribed burn. Such an estimate requires data and computations that are best handled by a computer.

A computer-based system for doing this job was developed at the Southeastern Forest Experiment Station. Since weather data were necessary for predicting smoke dispersion, some data were used to provide additional weather information, including localized forecasts, predictions about conditions for equipment use, and the likelihood of rust infection in nurseries.

An evaluation of the Forestry Weather Interpretations System (FWIS) shows a 6-to-1 benefit-to-cost ratio. A "Grass Roots Experiment," in which Georgia Forestry Commission personnel in 20 counties receive and relay county-level forecasts from FWIS, also delivers fire prevention and prescribed burning messages on days when it counts.



A weather information data system helps forest managers plan use of equipment and fire control. SE

Prevent Fires Before They Start

When large forest or wildland fires start, an interagency mobilization system is used to immediately dispatch fire fighters from all over the country.

Until recently, these mobilization procedures have not been available for fire-prevention specialists.

Working with staff of the Pacific Southwest Region, researchers at the Pacific Southwest Station developed mobilization procedures for fire-prevention specialists, similar to those used for fire-suppression crews. These prevention procedures were designed to reduce the number of human-caused fires in an area experiencing severe fire conditions and were first used in California in September 1979 during a period of extreme fire danger.

Key to the prevention procedures was an up-to-date statistical summary that predicted the number of human-caused fires that were likely to start during a given day of the week. Researchers used this forecast along with an early alert to warn the National Forests and Ranger Districts when fire danger and occurrence probability would become high and mobilization of fire-prevention specialists would have a high payoff.

These test runs demonstrated the beneficial potential of prevention procedures and established the basis for total mobilization of national fire-prevention efforts.

The Pacific Southwest Station, in cooperation with the Institute for Social Research, University of Michigan, developed a National Plan for Wildfire Prevention. The National Plan will help make it possible to carry out a coordinated program of fire-prevention research involving Federal agencies, all 50 States, and colleges and universities.



After logging ponderosa pine forest, forest fuels are appraised. RM

Appraising Forest Fuels

Each year roughly 115,000 wildfires burn over 2.4 million acres in the United States. Wildfires are particularly troublesome when they burn in heavy fuel concentrations that result from timber harvesting or thinning.

One way to reduce wildfire hazard is by direct treatment of these fuels, but fuel treatment is expensive and the costs are rapidly increasing. Land managers will have to choose the most cost-effective treatments.

Rocky Mountain Experiment Station scientists have developed a system that will estimate the extent and severity of wildfire expected under different fuel treatment strategies. Managers can use this estimate to help determine which fuel treatments—if any—should be used.

The Activity Fuel Appraisal System combines fire and fuel modeling, historical fire and weather data, and principles of decision theory into an analysis that allows the land manager to consider wildfire occurrence risk, fuel quantities, climate, and suppression capability when evaluating fuel treatments. This system is currently being applied by the Ashley and Black Hills National Forests, the Wyoming State Office of the Bureau of Land Management, and by the Colorado State Forest Service.

Fire Behavior Can Be Predicted

Predicting fire behavior! Impossible! Not at all. The development of a custom programmed micro chip for use with a handheld calculator has now made it possible for the fire manager to quickly tell what a fire will do.

Fire behavior research has been underway for many years at the Intermountain Experiment Station. The micro chip developed in 1979 puts these years of research results into a form fire managers can use quickly and conveniently.

The chip allows fire control personnel to calculate the National Fire Danger Rating indexes to assess fire danger before a fire occurs. In addition, and perhaps more important, predictions of actual fire behavior from on-site assessment of fuels, weather, and topography can now be calculated. Fire managers are now using this important tool to determine fire severity in surface fuels, and to determine when conditions reach that critical and dangerous state where fires can be expected to race destructively through forest tree crowns.



Micro-chip allows fire control personnel to predict fire behavior. INT



Insects and Disease

Joint International Research

The Canada/United States Spruce Budworms Program (CANUSA) is a joint international effort between the Forest Service and the Canadian Forestry Service to develop effective spruce budworm management techniques. CANUSA has completed its first full year of activity with full funding. A considerable number of research proposals, cooperative agreements, and contracts were funded to support activities ranging from basic biological studies to a comprehensive integrated pest management plan.

The geographic distribution of investigators ranges from Maine to California and from the Lakes States to Georgia plus several Canadian Provinces. These investigators represent United States and Canadian universities, USDA Forest Service and Canadian Forestry Service Units, private contractors, and private timber companies.

In the first field season some promising results seem to be developing in the following areas: Monitoring of spruce budworm populations with pheromones, automatic egg mass counters, damage and hazard rating techniques, environmental impact and assessment of chemicals, improved application technology for chemicals and biologicals, and appraisal of pre-salvage strategy for budworm management.

In addition to these areas, CANUSA supports an integrated pest management demonstration in Maine aimed at reducing budworm damage by developing management plans for specific tracts that use silvicultural treatments, harvesting, and more precise spray application. This is a joint effort with the University of Maine, several private timber companies, and Baxter State Park.

Root Parasites of Southern Forests

Root parasites were virtually unknown to southern foresters until 1969 when a Forest Service scientist reported that *Senna seymeria* was killing 3- and 4-year-old slash pines in a large plantation in northwest Florida. A series of studies by Old Dominion University and Southern Forest Experiment Station has identified the significance of southern root parasites as pathogens of both pine and hardwood species.

The most familiar parasitic plants are the mistletoes that penetrate stems and branches of trees and shrubs. Root parasites act similarly below ground, forming specialized knob-like organs, called haustoria, that attach to and penetrate roots of neighboring plants. This provides a pathway for the transfer of water and food from the host to the parasite. Parasites depend on host plants for subsistence in varying degrees. Several species are capable of maturing and producing seed without attachment to a host. Some parasites attach to a wide variety of hosts, while others are much more specific.

The information gained from these studies gives geographic range, host selection, habitats, and keys for identification of the most prevalent southern root parasites.



Root parasites below the ground destroy the pines. SO



Pheromone control of pine shoot borer is working well, PNW

Biological Control for Pine Shoot Borer

A biological strategy has been developed to control the western pine shoot borer with an artificial version of the insect's own attractant or pheromone. Research by the Pacific Northwest and Pacific Southwest Forest Experiment Station and Weyerhaeuser Company has shown that when the artificial sex attractant is applied in amounts slightly greater than occur naturally, male moths can become confused and this can prevent them from finding females. Reproduction is blocked, shoot borer populations decline, and damage to pine plantations is reduced. The attractant is highly specific for the shoot borer and is not toxic to humans or other organisms.

The shoot borer is a pest of ponderosa pine and jeffrey pine plantations throughout the Western United States where growth reduction is estimated at \$200 per acre. The larvae mine inside the new terminal shoots where they cannot be readily treated with insecticides. Practical methods for both aerial and ground application of the pheromone have been developed; when the pheromone is registered for commercial use, insect damage can be controlled at very low cost. A single treatment of less than one-fourth ounce per acre will reduce damage 70 to 90 percent.

Pheromone control is now recognized as a means of pest management that avoids the use of chemicals potentially harmful to the environment. This is the first case in which a pheromone control strategy has been shown to reduce damage by a forest pest.

Identify Pacific Coast Conifer Diseases

Forest Service plant pathologists with the assistance of State, county, and university organizations, as well as the Canadian Forestry Service, have developed a major publication that provides basic information needed to identify the common diseases of Pacific Coast conifers. Except for a number of texts written on forest and plant pathology, most of the available literature has been in the form of bulletins, monographs, articles, and shorter contributions issued from time to time through a variety of publication outlets. This handbook, *Diseases of Pacific Coast Conifers*, USDA Agriculture Handbook No. 521, brings all the basic information together under one cover.

The publication describes hosts, distribution, damage, disease cycle, and identifying characteristics for 31 needle diseases; 17 canker, dieback, and gall diseases; 23 rusts; 8 root diseases; 15 forms of mistletoe; and 18 forms of rot. Diseases in which environmental conditions are contributory factors are also described.

This information will be useful throughout Western North America where most of these diseases occur.



*Bacterial gall of Douglas-fir caused by the bacterium *Pseudomonas pseudotsugae*.
PSW*



Tiny parasitic wasps have been released in western larch forests since 1960. INT

Controlling the Larch Casebearer

Western larch forests of northern Idaho were silently invaded in the mid-1950's by a tiny moth called the larch casebearer. The moth was accidentally introduced into the Northeastern United States from Europe in the 1880's. Free of native European parasites, the casebearers bred rapidly and spread over most of the Northwestern United States and British Columbia.

Soon after discovery of the casebearer near St. Maries, Idaho, in 1957, researchers at the Intermountain Forest and Range Experiment Station began to study methods of biological control using small parasitic wasps that were native to the casebearer's homeland. In 1960 several species of wasps were imported and hundreds of thousands have since been released in infested stands. Researchers have also discovered local parasites that have added casebearers to their menu.

Results of this research are found in *Larch Casebearer in Western Larch Forests*, GTR-INT-55.

This publication contains information on casebearer life stages, biology, damage symptoms, and methods of evaluating outbreaks.



Products and Engineering

Putting Waste Wood to Use

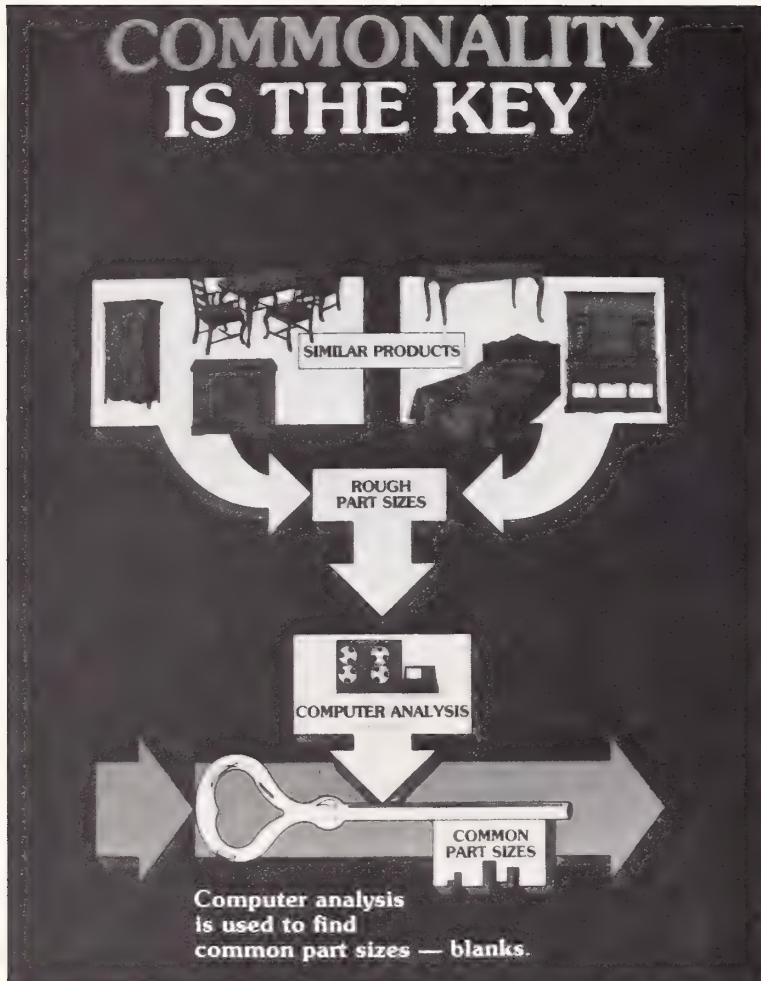
Cutting of trees and tearing down of old houses to make room for new construction are everyday occurrences in major cities. Ever wonder what happens to the wood? In most instances it goes to the dump; it is not used. Approximately 20 percent of the material entering landfills in the Southern United States is urban waste wood.

Perhaps the saddest chapter in this story is that technological systems for putting this waste wood to use are available, but seldom used. To correct this situation, scientists at the Southeastern Forest Experiment Station called a conference of municipal and county waste management officials and other interested parties. Attendees were informed about the possibilities of using urban waste wood in the South. Scientists and engineers described the systems that were available. They discussed the technical, financial, and legal barriers to full utilization of this important supply of wood. Papers presented at the conference were reproduced, and copies were sent to interested people who were unable to attend.

Full utilization of urban waste wood would have several obvious advantages. It would decrease the space cities require for landfills, provide a largely untapped source of energy and fiber, and help reduce our dependence on oil and natural gas for energy.



Urban waste wood is vastly under utilized. SE



System 6 and Sem are now in use for using low-grade hardwood of the Northeast in high-grade uses. NE

New Ways for Using Low-Grade Hardwoods

Researchers at the Northeastern Forest Experiment Station have found that some of the abundant supply of low-grade hardwood in the Northeast can be used for high-grade uses. They feel that *commonality* (or standardization) is the key.

Using computers, researchers have determined the standard-sized blanks that should be used to manufacture thousands of furniture and cabinet parts without a great deal of waste. They have also found ways to convert the presently unused timber to the standard-sized blanks.

System 6 is a technique of converting 6-foot long bolts to blanks and Sem (Serpentine end matching) is a technique to make long pieces out of short pieces of wood. Timber for processing is obtained from forest thinning cuts. This promotes growth of the best trees. Industry is very interested in this system and has been cooperating with researchers in its development.

To date, thinning material from three National Forests has been converted into 6-foot bolts, processed using System 6 and Sem methodology to standard-sized blanks, and the blanks have been used by five furniture manufacturers to make tables, chairs, kitchen cabinets, and upholstered furniture.

Structural Flakeboard Results

Studies of structural flakeboard indicate that structural grade exterior sheathing can be manufactured from hardwood and softwood residues. This research considered the harvesting, materials, processing, economic, and marketing aspects of board manufacture. Products produced have met building code requirements for roofs and floors, and have met the Class B flame spread rating and exceeded the fire endurance requirement for exterior walls of one- and two-family dwellings.

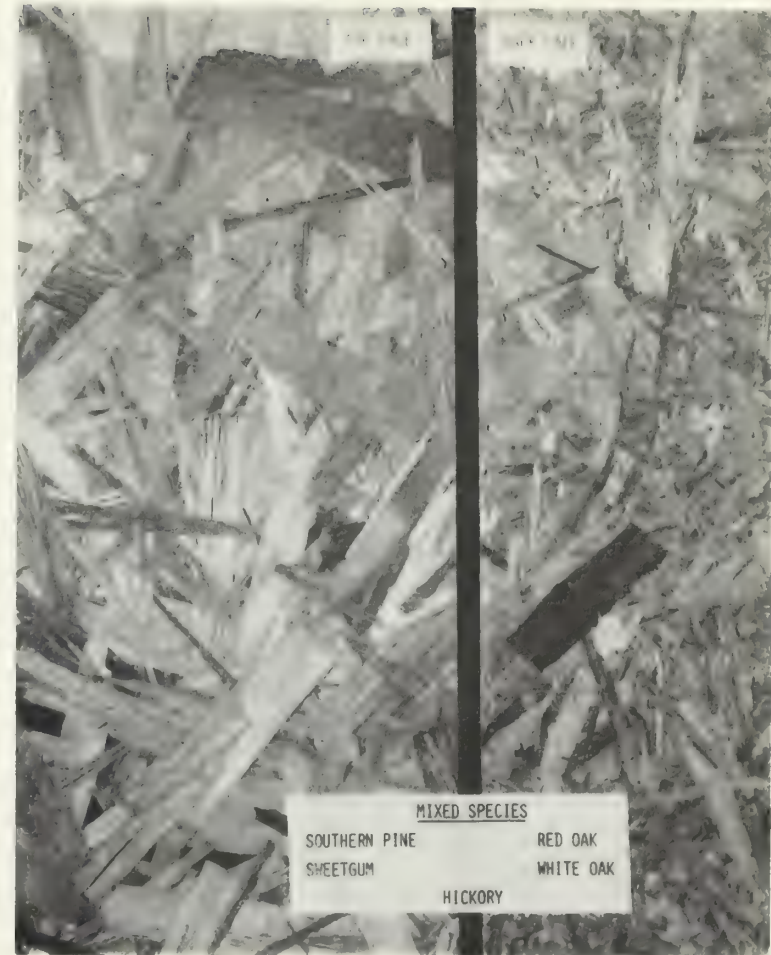
The results of this Forest Products Laboratory research are available to industry to help decide whether or not to expand the number of flakeboard plants. Flakeboard manufacturers have announced that in the United States, the number of plants has risen from 2 to a potential of 17 to 25 plants.

Commercial Use of Southern Hardwoods

The major unused wood resource in the South is low-grade hardwoods growing on pine sites.

Scientists at Southern Forest Experiment Station have been studying new processes for utilizing these low-quality, short, crooked hardwood logs. One promising result is hardwood structural flakeboard. This panel product would use large quantities of hardwoods as a substitute for lumber and plywood products from softwood. Flakeboard can be used for roof decking, sheathing, subfloors, concrete forms, containers, pallets, etc.

The shaping-lathe headrig was developed to convert short, low-quality logs into crossties or posts, cants for resawing, or cylindrical bolts to be rotary peeled. Flakes of uniform length and thickness are residue from the headrig and are excellent for use in manufacturing structural flakeboard. Fabrication techniques and an effective, economical resin system for gluing flakeboard of mixed southern hardwoods also resulted from this research. This new process is now available to the forest industry.



Structural flakeboard produced from both hardwood and softwood. FPL

New Products from Veneer

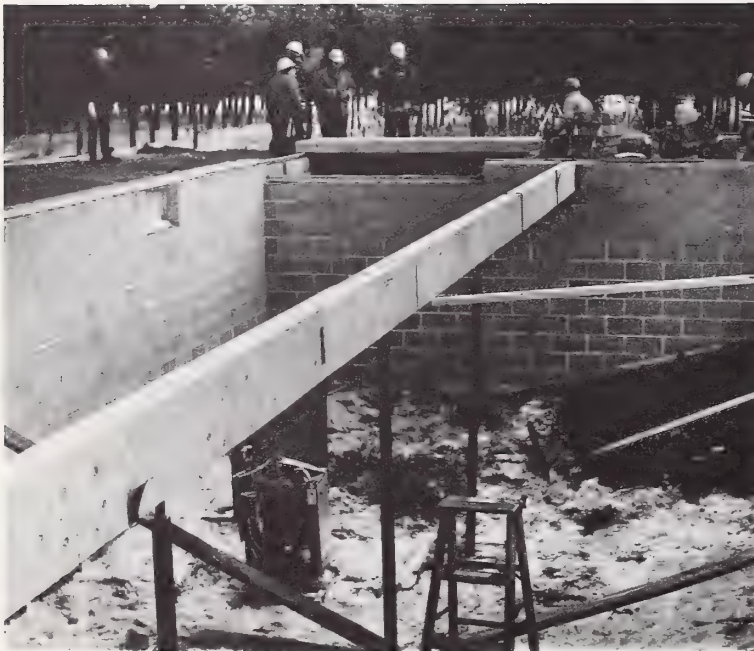
Upholstered furniture frames are currently produced from mixed hardwood lumber. Many manufacturers report difficulty in obtaining adequate quantities of long and/or wide parts from low-grade lumber. Since the frame is covered by upholstery, appearance is not a factor.

Purdue University and Forest Products Laboratory researchers have conducted a study that shows the feasibility of producing such lumber for furniture frames from parallel-laminated, thick-rotary-cut veneer.

The primary advantages of producing lumber by this process are increased yield over conventional sawing, more uniform strength and stiffness than lumber sawn from a comparable quality of logs, and product dimensions not limited by log dimensions.

The University of Washington and the Forest Products Laboratory have studied the use of reconstituted materials such as parallel-laminated veneer, which offers the opportunity to use lower grade, little used, and/or smaller raw materials for the manufacture of engineered wood components or finished products.

A number of potential market areas have been identified for this type of material and include ladder rails, mobile home ridge beams, purlins, crossarms, joists, glulam beams, and mobile home truss chords.



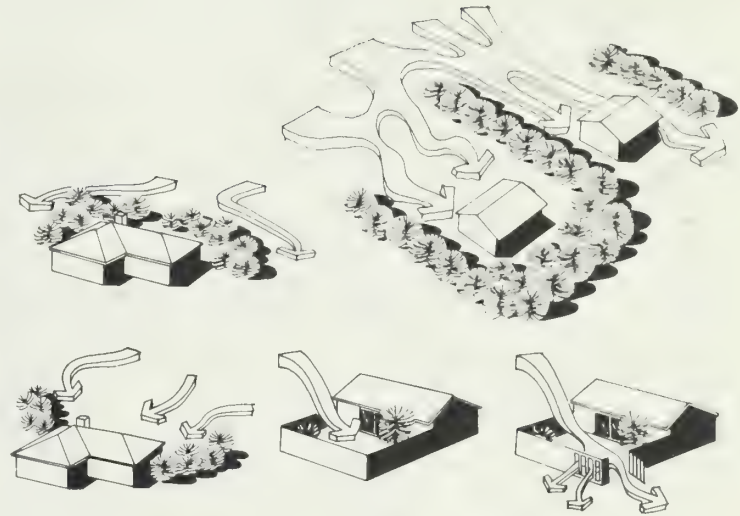
Parallel-laminated veneer from low-grade and infrequently used materials can be used in many products. FPL

Build in Energy Efficiency

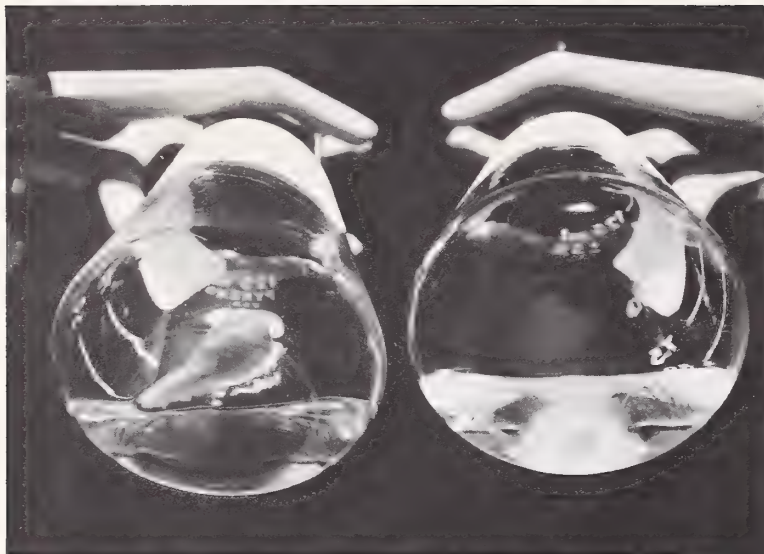
Energy saving features are emphasized in a new research paper, *Energy Efficiency in Light-Frame Wood Construction*, FPL-317. The paper provides innovative ideas on the design and construction of energy efficient light-frame wood structures.

Charts and graphs will be of considerable interest to engineers, designers, architects, and builders. Forest Products Laboratory research presents the role of housing design and landscape planning in building energy efficient homes, as well as the need of engineering for energy efficiency.

Topics include building code considerations, heating losses and gains, zoning for energy balance, windbreaks and air leakage control, thermal performance, and insulation. The paper describes how bedrooms with an easterly orientation offer sunlight in the morning, but not during hot summer afternoons, and how a southwesterly exposure gains solar heat in the winter. This energy efficient guide can make a significant improvement to our national energy problems.



Housing and landscape design helps make new homes energy efficient. FPL



Left flask contains bleaching waste at start of treatment. Right flask shows effective color removal. FPL

Lignin Research Holds Practical Promise

Lignin, a major component of wood, is the second most abundant renewable biomass resource on earth. Nature can break down lignin but in the past we have not known how microbes recycle lignin, or how this system might be used in wood utilization. Research has given us a clear understanding of which microbes degrade lignin, how the lignin is metabolized by these microbes, and what environment and nutritional factors favor lignin biodegradation.

Three applications have been demonstrated on a laboratory scale: (1) Partial bleaching (delignification) of kraft pulp with microbes reduces the chlorine requirement for the subsequent chemical bleaching. This lowers pollution from chlorinated lignin residue. (2) Microbial modification of lignin in coarse mechanical pulp lowers the energy requirements for final refining (fiberizing) in production of quality mechanical pulps. (3) Microbial action decolorizes dark colored bleaching wastes, which resist conventional biological treatment.

Microbial action is considered to be the most promising process of the three for technical-scale development and is being further studied by the Forest Products Laboratory in cooperation with four large pulp companies and North Carolina State University. Continued basic research is expected to increase the number of potential applications of microbial lignin-degrading systems.

Lumber Use by Truss Fabricators

Shortages of softwood lumber is one reason home building costs are increasing. The truss frame construction system developed by Forest Products Laboratory saves lumber and reduces costs. The use of frame material is reduced by 30 percent.

Studies by the North Central Forest Experiment Station and the Forest Products Laboratory show that builder prejudices and architect influences are major obstacles to greater use of trusses; that raw material procurement and lumber warp are major industry problems; and that variation within some lumber grades, conflicting interpretation of the same regulatory codes, and builders' lack of knowledge about trusses are major truss fabricator concerns.

Study results have helped large lumber manufacturers improve their production and marketing practices. The Truss Plate Institute and the Component Manufacturers Council have developed programs to focus members' attention toward improvement in truss marketing and lumber procurement practices.



Study results in information to help lumber manufacturers improve production and marketing practices. NC



Forest residues can help us with our Nation's energy needs. NC

Energy from Residues and Simulated Harvests

Scientists have conducted a study of the pulp and paper industry in Michigan's Upper Peninsula and northern Wisconsin to see if industry could be energy self-sufficient through the use of forest residues. Studies showed the forests of the region could supply 40 million green tons of fiber annually. This is seven times the current level of fiber utilization. Half of this fiber is from conventional forest residues—rough and rotten trees, and tops and limbs.

The use of forest residues as an energy source for forest industries can contribute substantially to solving the forest industry's energy needs.

Study results show that 9 of the 10 major pulp and paper mills within the study region could become economically energy self-sufficient through the use of forest residues by 1980.

Simulation or computer modeling is one way loggers can stay ahead of problems concerning machine purchase and operation. Recent application of improved simulation languages by the North Central Forest Experiment Station to full-tree field-chipping systems has shown that harvest models can predict real system output within 10 percent. Using these models, many different combinations of equipment and operating procedures can be tested within a fraction of the time and money required to examine just one real operation.

More efficient harvest systems will provide greater incentive for growing more wood for the future. The harvest model was used in the Forest Residue Energy Program study sponsored by the Department of Energy.

Dead Timber is Valuable

The rising price of lumber combined with the desire to improve wood utilization has resulted in more extensive use of a resource once considered valueless—timber dead and dying from insect attack. Approximately 1.2 billion cubic feet of standing dead timber exists in the northern Rocky Mountain States alone.

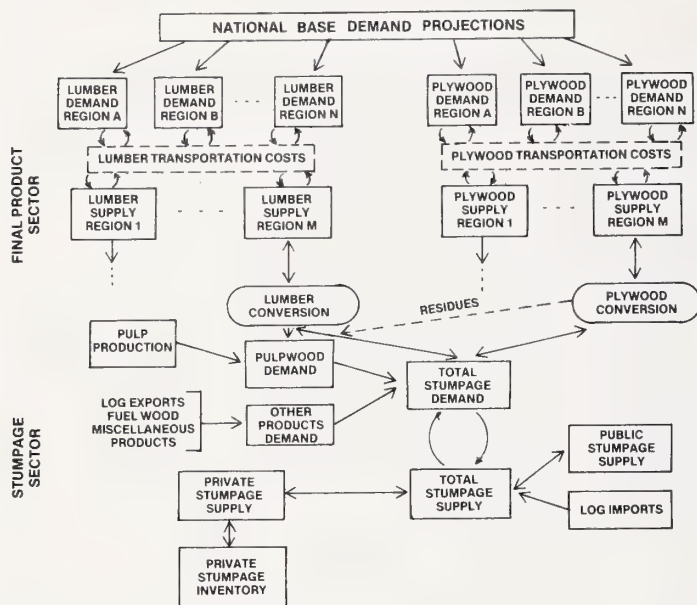
Studies at the Pacific Northwest Experiment Station and at the Intermountain Forest and Range Experiment Station show that much dead timber thought to be unmerchantable is actually satisfactory for lumber and other forest products. Researchers have worked with public forest managers and private industry to revise timber appraisal guidelines, set utilization standards, and lower log diameter limits to increase utilization of the dead timber resource.

Information gained from these studies has been applied in various ways and is providing needed wood for American consumers, reducing the fire hazard of dead stands and wood waste in managed forests, and benefiting forest products industries in small towns throughout the West.

The potential dollar benefits are also great. Approximately \$1 can be returned to the national economy for each cubic foot of dead timber processed as sawtimber. The total salvageable sawtimber in the West is estimated at 5.5 billion cubic feet. If only 10 percent of that volume were utilized, the value to the economy would exceed \$500 million.



Dead timber is an underestimated wood resource. INT-PNW



Economic gains are small from increased timber harvest on public lands, PNW

Analyzing Significant Policy Issues

The issue of setting aside large additional areas of the National Forest system as wilderness areas has generated much controversy. The benefits and impacts of alternative courses of action were the subject of close examination during the recent Roadless Area Review and Evaluation (RARE II).

One statement said that as much timber could be harvested without logging within the roadless areas, if the monies saved by not building roads were used to intensify management on the remaining forest lands. Researchers at the Pacific Northwest Forest and Range Experiment Station tested this hypothesis in seven western National Forests. Because of environmental constraints to significantly increased timber management and harvesting on the lands outside the roadless areas for the forests studied, researchers concluded there were limited opportunities to intensify management through increased investments in intensive management of accessible areas.

Since the seven forests were not construed to be a scientific sample, no firm conclusions on this issue can be drawn for other National Forests. The study does suggest there may be similar limitations for other western National Forests and that the issue of increasing management intensity on accessible areas is very complex and extends beyond questions of available management monies alone.

Another issue associated with RARE II has been the likely impact of massive withdrawals of unroaded National Forest land from future timber harvesting on future wood product output and prices. Research economists analyzed the potential effects of withdrawing all roadless areas being studied. Their conclusions were that while there could be

severe impacts on local and subregional economies in the West, the overall long-term effect would be to increase softwood timber harvesting in other parts of the country and also to stimulate greatly increased imports of Canadian softwood lumber.

These studies provide a factual basis for the resolution of complicated issues in the management and use of forests and forest-related resources.

Improved Scientific Information

The Forest and Rangeland Renewable Planning Act of 1974 as amended by the National Forest Management Act of 1976 directs the Secretary of Agriculture to prepare periodical reports to the Congress on the Nation's renewable natural resources. The Renewable Resources Assessment is a supporting technical document for these reports to Congress on the Nation's renewable resources. The second Assessment prepared in response to this legislation was submitted to Congress in January 1980. The major findings of the Assessment are that while trends in the consumption of most forest and range land related goods and services show that future demands may well outstrip future supplies, there are many opportunities for remedial management programs to prevent such future shortfalls.

In preparing the Assessment, new scientific information, resource data, and analytical methodologies were developed by Forest Service scientists at various locations throughout the country.

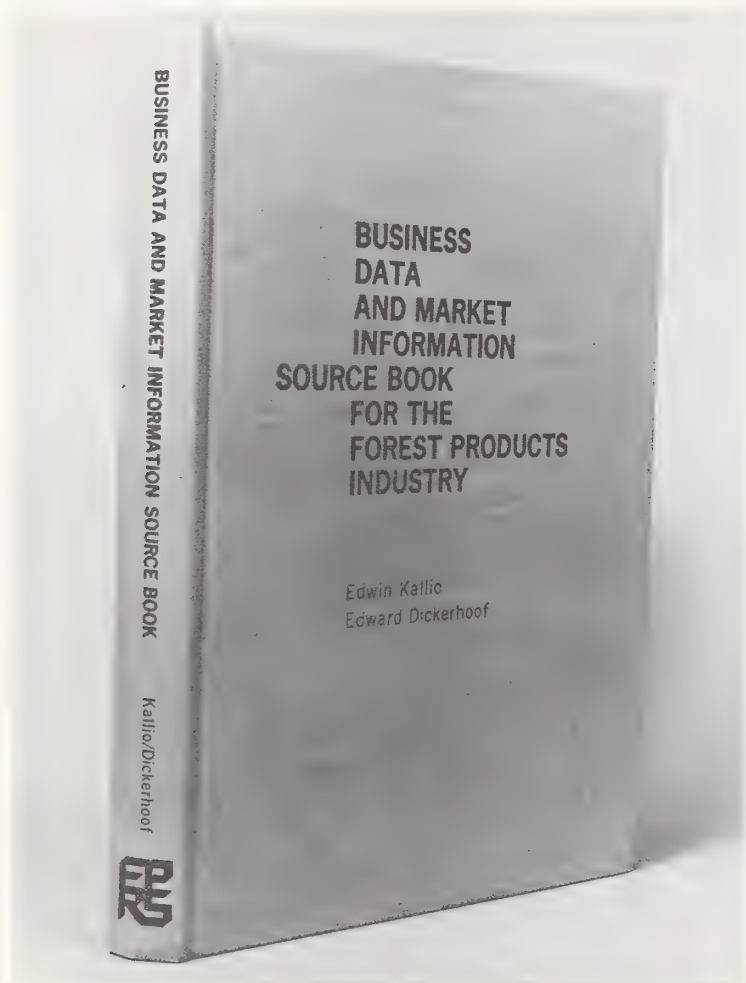
In 1976, South Carolina was selected as one of the six pilot study areas in the United States to be highlighted in the 1980 RPA Assessment. The specific mission in South Carolina was to develop and test procedures for multiresource inventories. Renewable Resources Evaluation scientists at the Southeast Forest Experiment Station had been involved in a number of innovative nontimber resource studies and had formulated new conceptions of the additional inventory needs.

Previous inventories had focused primarily on timber. While they provided the official estimates of total forest acreage, detailed classifications and measurements were generally confined to lands classified as commercial timberland. The new forest inventory of South Carolina is the most comprehensive State multiresource inventory ever completed.

The new inventory for South Carolina will allow foresters, range specialists, wildlife biologists, recreation specialists, ecologists, and others to draw upon a common data base. It should provide an understanding of the ecological relationships that affect resource benefits when land is used for several purposes simultaneously. As experience is gained in analysis of multiresource inventory data, procedures will be improved and incorporated into operational inventories in other States.

The nationwide inventory and analysis of renewable forest-land resources was initiated at the direction of the Forestry Research Act (McSweeney-McNary) of 1928 and continues under the authority of the Forest and Rangeland Renewable Resources Planning Act of 1974 and the Forest and Rangeland Renewable Resources Research Act of 1978.

State-by-State inventories were conducted on nearly 50 million acres of forest land this year. Analysis and publication of these resource data provide the sound technical information base required for resource decisions and policy at multicounty, State, regional, and national levels. In addition to providing forest area and productivity data to the public and the various forest-related industries, several specific applications were made of these resource inventories for the evaluation of alternative energy sources.



Business Data Book is now available. NC

Business Data and Market Information Source Book

Market analysts at the North Central Forest Experiment Station and the Forest Products Laboratory jointly developed a reference source book, *Business Data and Market Information Source Book for the Forest Products Industry*.

This book contains comprehensive listings for sources of timber and wood products-related data, including economic statistics, directories, forest products reports and newsletters, price reports, pertinent periodicals, bibliographies, computerized information retrieval systems, and many other market information aids.

Timberland owners, small private wood processors, and others involved in the production, sale, and marketing of timber and wood products will find this book a valuable reference and information source.



Timber Management

Energy and Nitrogen from Red Alder

Red alder is the major hardwood species in the Pacific Northwest, where it has a reputation as a successful, but often unwelcome, competitor of conifers. Researchers at the Pacific Northwest Forest Experiment Station suggest that forest managers consider alder in their management plans.

There are many reasons. Alder is fast growing, outstripping associated conifers for the first 30 years. Its wood is suitable for many commercial products; it is a prime fuelwood. Alder covers a large portion of the low-elevation coastal forest area from Alaska to central California. In addition, red alder is the only important western tree species that adds nitrogen to the soil at the same time it produces usable wood.

Alder can be planted by itself for short rotations to produce fiber for pulp or fuel or it can be managed on longer rotations to produce solid wood products. Alder also has potential for use in reclaiming strip mine sites or areas where diseases now prevent conifers from growing.

A Conference on Management and Utilization of Alder was co-sponsored by the University of Washington and the Station. The published proceedings will be of considerable use to foresters, scientists, and land managers in planning the use of alder.



These ponderosa pine seedlings were grown in single cells and bundled for packing. RM

Container-Grown Seedlings are Better

Over the last 10 years researchers have found that seedlings grown in containers do not have limitations that are common to bare root seedlings. Because the root system of container-grown seedlings is intact and protected, cold storage is usually not necessary, and the seedlings can be planted successfully for a longer season.

Container seedlings can be programed for planting almost any time of year when raised in a specially designed greenhouse-type structure. In this kind of controlled environment, container-grown seedlings can be produced in one-quarter the time needed for bare root seedlings in outdoor beds. This enables nursery staff to quickly replant after large fires and to respond rapidly to changed logging schedules.

Research into seedling physiology, nursery hardware, and planting techniques have made possible the current North American production of more than 100 million container seedlings per year.

The research and practical experience of scientists and nursery staff have recently been assembled in a manual, *How to Grow Tree Seedlings in Containers in Greenhouses*, GTR-RM-60.

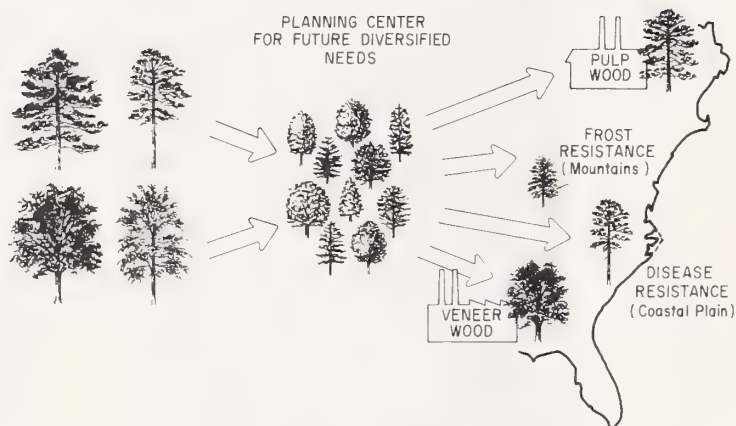
Radiography Advances Tree Seed Technology

Radiography provides a practical method for seed analysts to evaluate internal seed anatomy without destroying the seed. This method gives researchers detailed information on seed structure, development, mechanical injury, and insect damage. Used with other accepted tests, radiography helps draw accurate inferences about seed quality and can be used safely in the laboratory.

Researchers studied 24 radiopaque agents to see what the agent's capacity would be to promote the image contrast needed for accurate interpretation. With black walnut, shellbark hickory, and pecan seeds serving as test subjects, 20 of the agents improved images of either seed coat cracks, cavity outlines, healthy tissue, damaged tissue, or general contrast.

Seed analysts of Southeastern Area and the Southern Forest Experiment Station have authored a handbook to familiarize seed radiography users with materials, equipment, techniques, and terminology involved in preparing and interpreting radiographic imagery.

Timber Management



Tree breeding strategies using multiple populations will allow high genetic improvement in trees. SE

Tree Breeding Strategies

Scientists at the Southeastern Forest Experiment Station are studying the highly specialized field of quantitative genetics. They are concerned about the complex problems associated with breeding designs and strategies inherent in long-term tree breeding programs for improvement of multiple traits.

A system of tree breeding using multiple populations has been shown to be feasible. By dividing breeding populations into subunits, researchers have found that more genetic gain can be achieved than by using a single breeding population of comparable size. When the future is uncertain, as it generally is in forestry because of the long generational span, selection for different trait combinations or site conditions can be undertaken simultaneously by selecting for different responses among the subunits.

Using this approach, tree breeders can deploy multiple populations in several directions around combinations of high predicted future value. This practice will allow high immediate genetic improvement, guard against selection of improper direction, and provide genetic flexibility and variation in the tree breeding population for many generations in the future.

Management of Hemlock-Sitka Spruce Forests

Western hemlock-Sitka spruce forests occupy a narrow 2,000-mile strip along the Pacific coast from Oregon to Alaska. This type of forest is extremely productive and is a substantial part of the timber harvest in western Washington and coastal British Columbia. Nearly all of the timber harvested in Alaska is from hemlock-spruce forests.

Besides its value for timber, hemlock-spruce forests provide habitat for wildlife, and streams for spawning and rearing habitat for salmon and trout that sustain an important commercial sport fishery. Scenic and recreational opportunities are also provided for many people.

Researchers from the Pacific Northwest Forest Experiment Station recently published *Management of Western Hemlock-Sitka Spruce Forests for Timber Production*, GTR-PNW-88. This publication describes current timber management practices and includes practical guides for management.



Beautiful western hemlock-Sitka spruce forest is valuable for wildlife and productive for timber. PNW

Yellow-Poplar Harvests Can Be Doubled

Scientists have found that yellow-poplar harvest rate can be doubled in the Eastern United States. The significance of this finding is that more yellow-poplar can be used to manufacture many products now made from pine. Rough construction plywood, many kinds of paper products, as well as studs and sheathing for housing, can be manufactured from yellow-poplar. This will help relieve pressures now being exerted on the southern pine resources.

Researchers have found there is no need for intensive management of yellow-poplar to bring about these increased supplies. Custodial management, permitting a forest to regenerate and grow as it will and harvesting timber at the landowner's convenience, is responsible for the current rate of yellow-poplar growth. There is no need for large investments at the time of harvest and regeneration that must be carried forward at high rates of interest for 40 to 80 years.

The minimum cultural practices for custodial management are (1) keep harvested areas larger than 1 acre, (2) remove or fell all trees larger than 2 inches d.b.h. at the time of harvest, (3) protect the young stand from fire, and (4) schedule the next harvest according to the owner's best interest.

These guidelines will be of interest to land managers and landowners throughout the central and southern Appalachian forest region where yellow-poplar predominates as a commercially important timber producing tree.



Yellow-poplar growth is two and one-half times greater than removals. SE

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Environment

Environment

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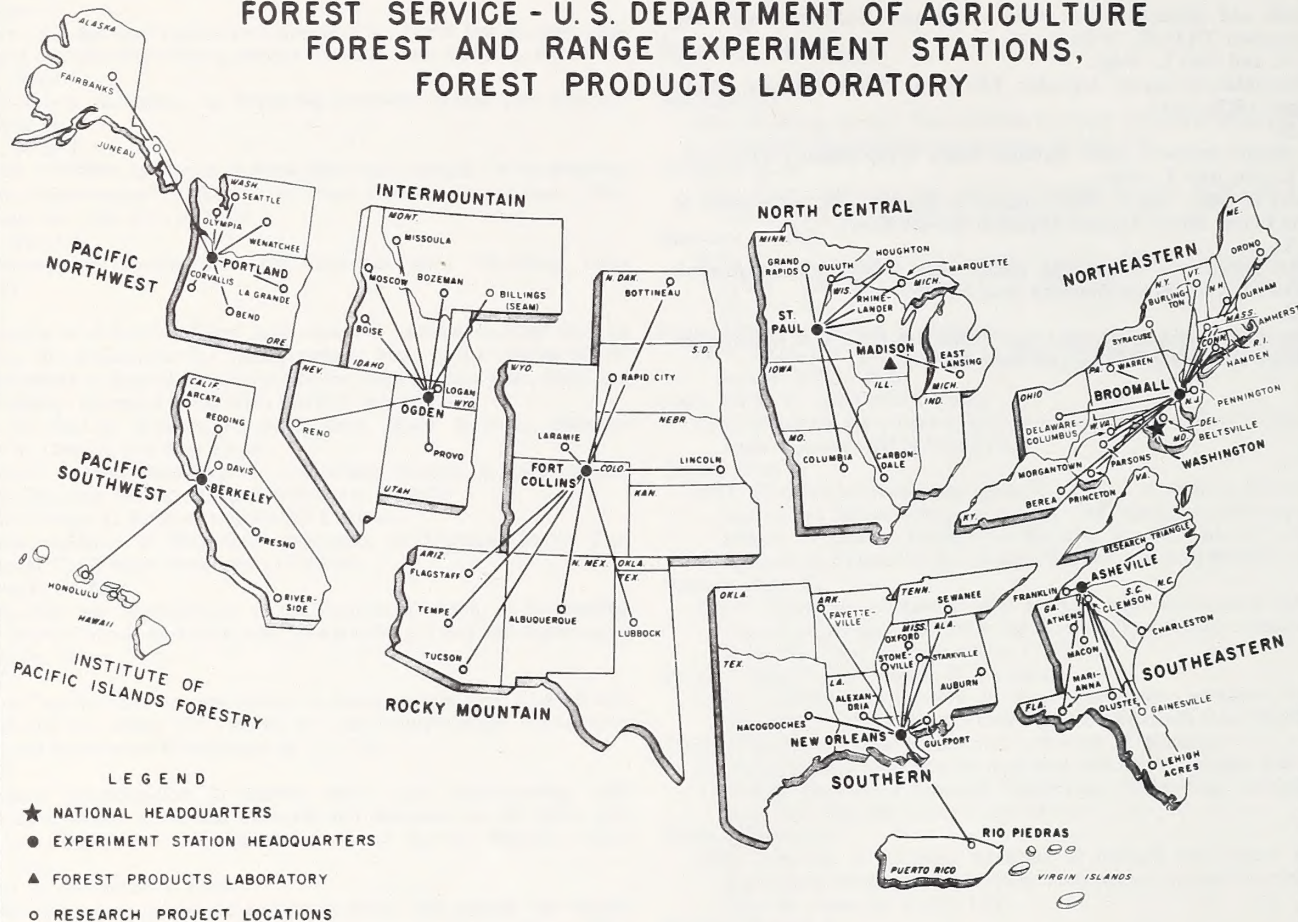
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